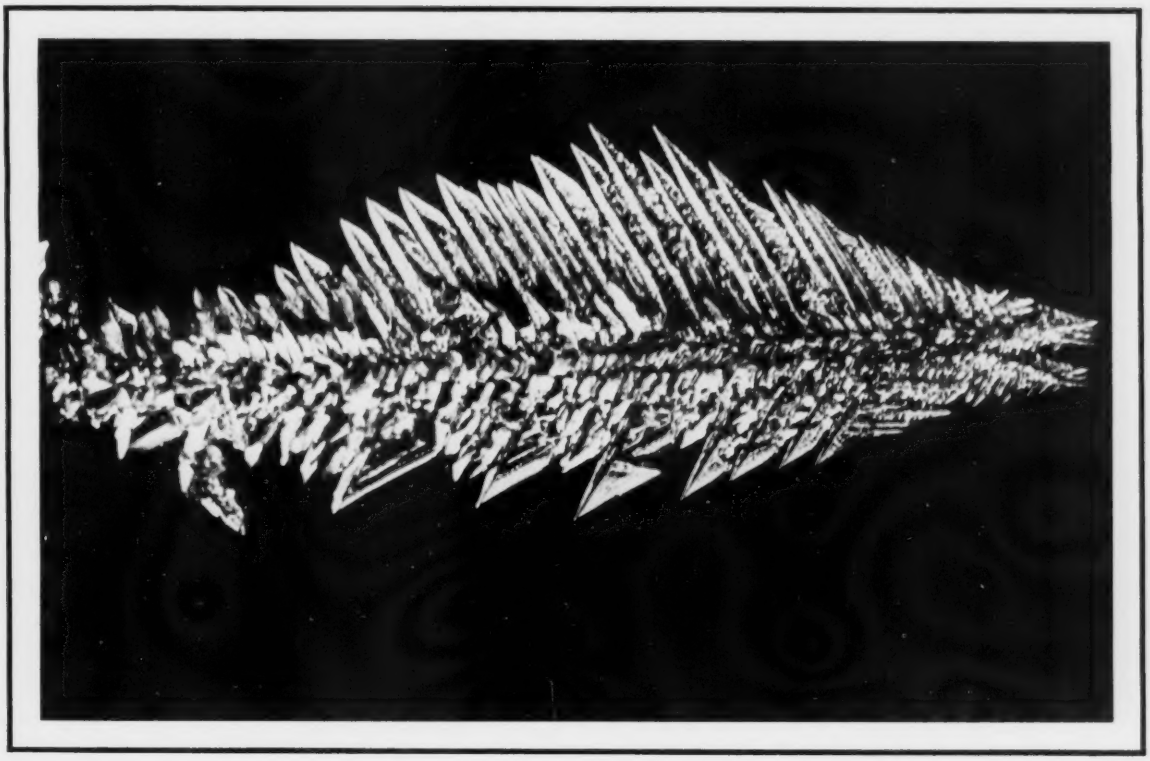
NATIONAL BUREAU OF STANDARDS *May/1969*

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

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NATIONAL BUREAU OF STANDARDS

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MAY 1969/VOL. 53, NO. 5/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

CONTENTS

COVER: *What appears to be the fossil of a prehistoric fish is actually a copper dendrite (electrocrystallized at 250 mA and pH 3.4 in a dilute solution of cuprous chloride). The dendrite was formed by the NBS Metallurgy Division in experiments to determine conditions for growing large copper crystals. Magnification: 3.5.*

Prepared by the NBS Office of Technical Information and Publications, Washington, D.C. 20234

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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IMPROVED
Dental Splinting Material

Fractures of the Jaw Are Common occurrences in both combat and day-to-day accidents. Treatment of those fractures usually involves splinting of the jaw using archbars that are not only traumatic to oral tissue but are time consuming to apply and require the services of highly trained personnel with specialized laboratory equipment and facilities. Improved splinting techniques and materials have been needed for some time.

This goal has apparently been reached at the NBS Institute for Materials Research in a study sponsored by the U.S. Army Dental Corps. A polymeric splinting material has been developed by G. M. Brauer and J. W. Kumpula of the NBS Polymers Division in a joint effort with Drs. E. F. Huget and S. Civjan of the U.S. Army.[1] This material polymerizes in the mouth in 4 to 7 minutes at a peak temperature not exceeding 50 °C. Tests have shown that it has sufficient strength, rigidity, and dimensional stability to function as a splint, to aid reimplantation of teeth, and possibly to have other medical applications. Clinical experiments have shown that its low-setting temperature reduces both patient discomfort and soft-tissue damage.

The material consists of 49.8 percent finely ground poly(methyl methacrylate) powder mixed with 0.2 percent benzoyl peroxide and 50 percent calcium carbonate filler. When this powder is mixed with a monomer, methyl methacrylate with 0.2 percent N,N-dimethyl-p-toluidine, a dough-like stage of polymerization is obtained in less than 1 minute.

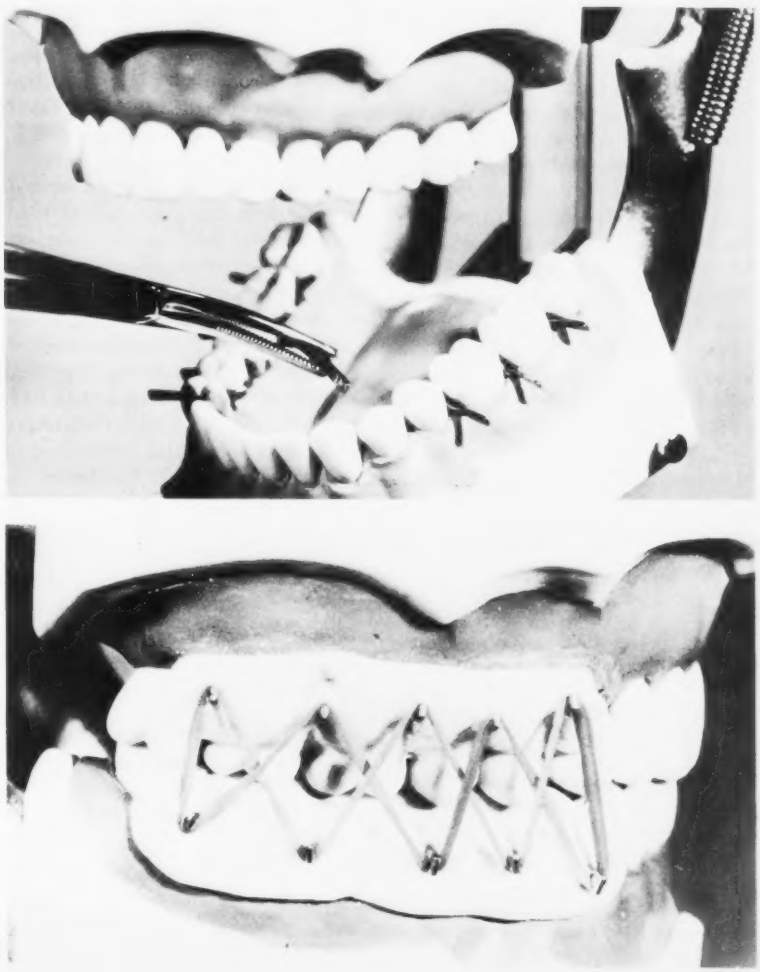
The dough-like material can be readily adapted to the cervical third of the intact teeth. It exhibits highly desirable manipulation and setting characteristics that eliminate many of the difficulties associated with materials used for direct splinting.

Preformed, spring-like lingually inserted clasps prevent the buccal displacement of the polymerized splint and serve as anchor points for interarch elastics.

Tests have been performed on the material in accordance with American Dental Association specifications. It was found to possess properties similar to those associated with denture cold-curing repair resins. Clinical experience with this material by the U.S. Army Dental Corps has been entirely satisfactory.

[1] Huget, E. F., Brauer, G. M., Kumpula, J. W., and Civjan, S., A rapid curing, low peak temperature acrylic splinting material, J. Am. Dental Assoc. (to be published).

Top: Preformed pins are inserted as anchor points for interarch elastics before applying splinting material.
Bottom: Interarch elastics hold the polymeric splinting material demonstrated on this denture model.



MAGNETIC DIPOLE TRANSITIONS IN CYANIDE RADICAL

In Recent Work at the NBS Institute for Basic Standards, the magnetic dipole transitions between the perturbed Π state and the Σ states of the cyanide radical were accurately measured and identified.[1] Spectral lines obtained in this work by K. M. Evenson at the NBS Laboratories in Boulder, Colo., correspond to 11 of the 13 predicted magnetic dipole transitions. It is thought that this is the first microwave measurement of magnetic dipole transitions between excited electronic states of a molecule. Such measurements should lead to increased understanding of molecular transitions and find applications in laser technology.

Certain abnormalities, or perturbations, in the violet bands of the cyanide spectrum were observed as early as 1928.[2] Later, it was found that the perturbed lines consisted of doublets, and it was proposed that the anomalies in the observed spectra were caused by rotational perturbations between two nearly coincident energy levels, the $v=10$ level of the $A\ ^2\Pi$ state and the $v=0$ level of the $B\ ^2\Sigma$ level.[3] For a given rotational level, the perturbation is now known to be caused by the interaction of one component of the Σ state doublet and one component of the Π state doublet. For each perturbation, there is a set of four closely spaced levels (a perturbed Π level, an unperturbed Π level, a perturbed Σ level, and an unperturbed Σ level); each separated by microwave frequencies.

Kenneth Evenson examines a newly designed x-band cavity, with optical window, which is used for observing microwave transitions of the CN radical.

The closeness of these energy levels permits microwave transitions among the levels; that is, transitions may be observed from the more populated Π level to the Σ level. Such transitions, which are essential to the analysis of perturbations, have been studied in several projects at NBS during the last five years. In 1964, three NBS scientists made the first microwave measurements of the fine and hyperfine structure of an excited electronic state of a molecule.[4] In later work the electric dipole transitions were used to obtain information on the collisional energy transfer between the rotational energy levels of CN.[5]

The transitions observed in this study were detected by measuring the increase in the intensity of a selected violet band (near 3875 Å) in the spectra of a cyanide flame.

The cyanide flame for the experiment was produced by the chemical reaction of active nitrogen and methylene chloride. Active nitrogen was produced in a discharge tube and pumped into an x-band cavity, constructed from a 12.5-cm section of rectangular waveguide. Small amounts of gaseous methylene chloride were then added to the cavity. Although various organic compounds react with active nitrogen to produce cyanide flame, the addition of 1.0 percent methylene chloride gives both a very stable flame and good emission intensity. The high stability and intensity were essential to the analysis of the weaker microwave transitions.

To observe the emitted spectra, a slot 5 mm wide and 6.5 cm long was cut on the broad side of the cavity. A "chimney" was soldered on top of the slot, and a glass window was attached to the chimney with hard wax.

A violet filter isolated the desired band of the cyanide spectra. The filtered light was then passed through a photomultiplier tube to detect the intensity changes of the light. The population increases in the individual rotation levels could then be observed with a monochromator.

An adjustable coupling screw on one end of the cavity made it possible to achieve maximum coupling (indicated by no reflected power) over the entire frequency range of the cavity. Pressure within the cavity was measured with a differential pressure meter connected to an end of the cavity. Microwave frequency measurements were made with a transfer oscillator and an electronic frequency counter. The microwave power level, measured with a thermistor and a power meter, was maintained

nstant to about ±5 percent during the microwave frequency scan.

Each of the 11 observed magnetic transitions occurred in the frequency range from 10.5 to 11.5 GHz. By moving a photocell lengthways along the cavity, it was found that the transitions occurred in the regions of maximum magnetic field intensity.

Agreement between observed and calculated values was quite good on all of the intense lines and two of the weaker lines. However, four of the weaker lines showed differences as great as a factor of 2, and one differed by a factor of 50. Deviations in the weaker line intensities are thought to be due to increased transition probabilities caused by the large hyperfine interaction between the unperturbed Σ and the perturbed Σ level.

The complete energy level scheme, including all 12 hyperfine energy levels, for this perturbation complex of cyanide can now be determined by combining information from magnetic dipole transitions observed in this experiment with the previous findings on electric dipole transitions.

This analysis revealed the previously unknown hyperfine splitting of the unperturbed component of the $A\ ^2\Pi$ state.

[1] Evenson, K. M.. Microwave magnetic dipole transitions between excited electronic states of CN, Phys. Rev. (Feb. 5, 1969).

[2] Herzberg, G., Spektroskopisches über das nachleuchten von stickstoff, Z. Physik 49, 512 (1928).

[3] Beutler, H., and Fred, M., Intensity anomalies by collisions in perturbed rotational bands, Phys. Rev. 61, 107 (1942).

[4] Evenson, K. M., Dunn, J. L., and Broida, H. P., Optical detection of microwave transitions between excited electronic states of CN and the identification of the transitions involved, Phys. Rev. 136, A1566 (1964).

[5] Evenson, K. M., and Broida, H. P., Measurement of collisional energy transfer between rotational energy levels in CN, J. Chem. Phys. 44, 1637 (1966).

Ultrasonic Determination of Liquid Equation of State

A SELF-CONSISTENT ULTRASONIC METHOD for determining the equation of state* of liquids at very high pressures has been devised at the NBS Institute for Basic Standards. The method, developed by P. L. M. Heydemann and J. C. Houck,[1] has been applied to several liquids at pressures up to 45 kbar.** Extension of the measurements over a wide temperature range also conveniently permits the determination of such parameters as the specific heat as a function of temperature and pressure.

The method requires only the measurement of the transit time of an ultrasonic pulse through the liquid as a function of pressure. The difficulties and errors connected with a direct volumetric determination are thus avoided and improved accuracy is achieved. This is a great advantage at very high pressures where a known path length cannot be provided.

In the NBS method, the sample is contained in a polyethylene sleeve inside a conventional high-pressure piston-cylinder assembly. Pulses with a half-width of about 0.4 μs and a carrier frequency of 10 to 12 MHz are applied through a transducer that generates and receives the ultrasonic signals. The time between the arrival of the reflections from the front and the rear of the sample are then measured with a calibrated, variable delay circuit. In liquids with a low attenuation coefficient, five or more multiple reflections usually suffice for the determination of the transit time. With five reflections the transit time can be determined to within 1 ns.

The internal pressure can be calculated from the ram pressure, the area ratio of the ram piston and the high-pressure piston, a parameter representing the reduction of internal pressure due to friction at very low ram pressure, and a parameter representing the change of the internal pressure due to friction per unit ram pressure.

From determinations of the transit time at this pressure, the length and thus the volume of the liquid sample can be calculated. This then leads to a determination of the density, the velocity of sound, and the adiabatic bulk modulus of the liquid.

To determine the accuracy of the method, it was used at NBS for density measurements on distilled water at 12.5 kbar, for which accurate data for comparison are available from other sources. With the exception of one point, the disagreement was never larger than the estimated total uncertainty of 0.4 percent. Estimated uncertainty at pressures up to 45 kbar are of comparable magnitude.

*An equation connecting those variables such as temperature, pressure, and volume, which define the physical condition of a substance.

**4.5×10^9 N/m^2 or approximately 650 000 psi.

[1] Heydemann, P. L. M., and Houck, J. C., Ultrasonic and dilatometric measurements at very high pressures, Proc. Symp. on Accurate Characterization of the High Pressure Environment, National Bureau of Standards, Gaithersburg, Md., Oct. 14–18, 1968.

David F. Wait sets the operating frequency of a compensation radiometer, which directly measures the temperature of noise generators without a mismatch error.

COMPENSATION TECHNIQUE MEASURES

Noise Generator Power

THE NOISE GENERATOR IS WIDELY USED as a standard of low-level, uniform density power. Usually, the available power density of a noise generator is measured in terms of a noise temperature. The noise temperature of a generator is the temperature that an ideal thermal source would have that has the same available power density. In the past, precise measurements of noise temperature were made with narrow band systems for generators which have very low reflection coefficients.

A method for measuring the available power of a noise generator by direct measurement of the noise temperature, independent of the reflection coefficient, has been demonstrated by scientists at the Bureau's laboratories in Boulder, Colo.[1] David F. Wait, of the Radio Standards Engineering Division, NBS Institute for Basic Standards, was the principal investigator. Dr. Wait was assisted by Toshio Nemoto, of the Ministry of International Trade and Industry, Tokyo, Japan.

The essence of the new method is a compensation technique, in which a compensation generator is used simultaneously with the generator being tested. In principle, when the available power of a noise generator is constant, the emergent power is reduced as the generator's reflection coefficient increases. This reduction is compensated for by an auxiliary generator.

An idealized system was described mathematically; then an experimental system was constructed for operation at the X-band frequency of 9 GHz.

In addition to the two noise generators, the experimental apparatus included a three-port circulator and a detector. The "unknown" noise source was composed of argon gas discharge tubes in series with variable attenuators. This rather sophisticated noise source allowed the researchers to vary the noise temperature over a wide range. The compensation noise source was made up of an argon discharge tube in series with a variable attenuator; however, the compensation noise source was more powerful than the unknown noise source. (The compensation generator must have more power than the unknown generator because of losses in the circulator.) The circulator was tuned before insertion into the circuit. The detector was a Dicke-type comparison radiometer with a resolution of 6 K for noise sources at 10 000 K.

During the experiment, the reflection coefficient was varied by a low-loss tuner consisting of an H-plane tee with a sliding short in the side arm. With a reflection coefficient of 0.5, the available power of the generator could be measured within 0.6 percent,[2] in addition to the uncertainty of the standard needed to calibrate the system. With a reflection coefficient of 0.01, the error [2] was approximately 0.2 percent. Therefore, the reflection coefficient has only a small effect upon the accuracy of the technique.

Misadjustment of the circulator, misadjustment of the compensation generator, thermal radiation from the detector, and thermal radiation from the circulator are the four major error sources. Each source was analyzed mathematically, and expressions for each error were derived.

According to Dr. Wait and Mr. Nemoto, their compensation technique can be modified to measure lower output generators (down to less than 1000 K). For sources where high accuracy can be obtained for relatively broad bandwidths, less expensive detection systems could be used for precision noise measurements. (The Wait-Nemoto technique is at present just as accurate as the most accurate methods available.)

[1] Wait, D. F., and Nemoto, Toshio, **Measurement of the noise temperature of a mismatched noise source,** IEEE Trans. Microwave Theory Tech. MTT–16 (Sept. 1968).

[2] This was determined by measuring a variable-reflection-coefficient noise source of known output.

DATA OBTAINED ON Electron Energy Losses

DATA ON ELECTRON ENERGY LOSSES for various materials obtained at the Bureau have given information on the electronic properties of these materials and the differences between the solid and liquid state. With support from the Atomic Energy Commission, C. J. Powell [1] of the NBS Institute for Basic Standards has obtained data on the amount of energy lost by fast electrons interacting with the electrons of different elements, both solid and liquid. These results should be of value to scientists in such fields as liquid- and solid-state physics and radiation physics.

In the NBS experiments, a specimen is bombarded by electrons of about 8 keV energy from an electron gun. Electrons, scattered through a preset angle, are decelerated, dispersed by an electrostatic energy analyzer, and detected by an electron multiplier. Graphs of the current to the multiplier as a function of a sweep voltage applied to the cathode of the electron gun are called characteristic electron energy loss spectra. These spectra show the relative probability of electron energy loss in the specimen for particular scattering angles.

Apparatus

A cylindrical, evacuated chamber, measuring approximately 40 centimeters in diameter and about 30 centimeters in height, is used in the electron energy loss studies. Ports in the chamber are used for vacuum connections and to introduce an evaporator filament.

A graphite rod supports the sample material in the center of the chamber. A heated filament around the support rod is used to heat the sample by electron bombardment to the graphite rod, and in this system specimen temperatures of 1200 °C could be obtained. The electron gun can be rotated about the specimen to vary the total electron scattering angle. The evaporator filament enables material to be deposited as a thin film on the specimen surface.

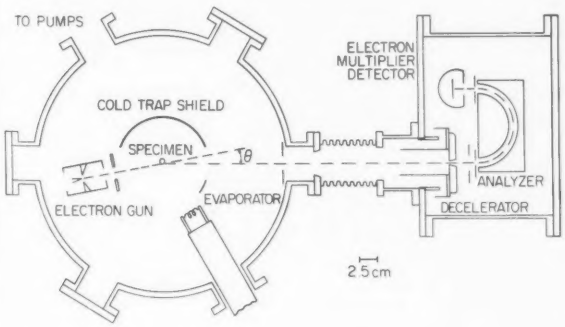


Diagram of apparatus used to obtain electron energy loss data. The electron gun bombards the specimen with electrons that are scattered through angle θ. The decelerated electrons enter the energy analyzer and are detected by the electron multiplier.

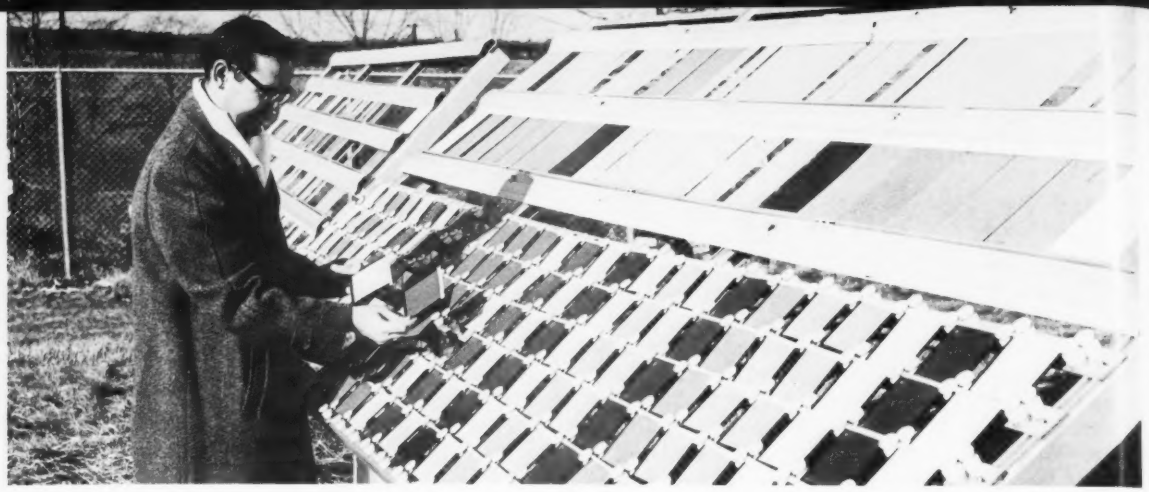
Cedric J. Powell adjusts the specimen's position in the large cylindrical chamber. Evaporator apparatus for producing thin films protrudes from the chamber (foreground). The electrostatic analyzer is in the chamber to the right.

Comparing Data

Characteristic electron energy loss spectra have been measured for aluminum, bismuth, gold, indium, gallium, and mercury, all in the liquid state. The same measurements have been obtained for three of the elements—aluminum, bismuth, and gold—in the solid state both when the sample was allowed to solidify and when the element was evaporated onto the specimen surface. In addition, energy loss spectra have been measured for liquid In-Al and In-Bi alloys.

The loss spectra for liquid aluminum are made up of combinations and multiples of an approximately 10 eV energy loss that occurs predominantly near the surface and an approximately 15 eV energy loss that occurs in the bulk. Change in the scattering angle (and thus of the average electron penetration distance) leads to changes in the relative number of 10 eV and 15 eV energy losses. Both losses varied slightly with temperature and changed by 3 percent at the melting point because of density changes. In bismuth, on the other hand, differences in the loss spectra on melting could not be interpreted solely on the basis of a density change but indicated a change in the electronic structure, as had been predicted from the known structural change. Studies in the liquid alloy specimens gave information on the changes in the electronic structure with composition.

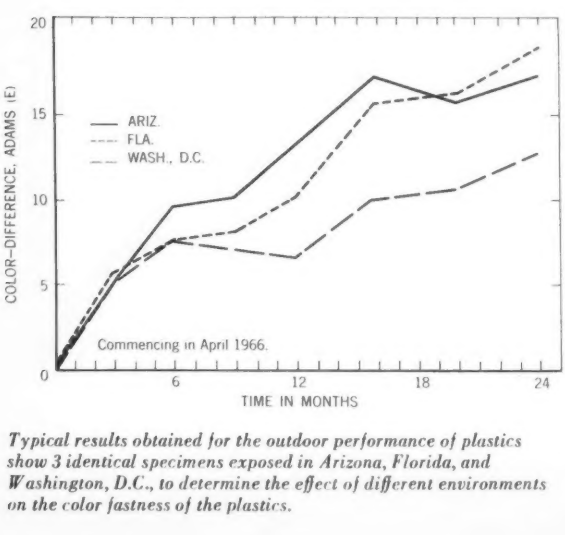
[1] Powell, C. J., Characteristic energy losses of 8 keV electrons in liquid Al, Bi, In, Ga, Hg, and Au, Phys. Rev. **175**, 972 (1968); Characteristic energy losses of 8 keV electrons in liquid In-Al and In-Bi alloys, Advances in Physics **16**, 203 (1967).



J. E. Clark examines plastic specimens exposed to outdoor weathering.

OUTDOOR PERFORMANCE OF PLASTICS

WITH A GOAL OF BEING ABLE to predict the outdoor performance of plastics, the NBS Institute for Applied Technology is currently studying plastics performance under outdoor and accelerated exposures.[1] After two years of the study, over 10 000 observations have been obtained on such properties as appearance and physical changes for specimens exposed in Arizona, Florida, and Washington, D.C. This work was performed by J. E. Clark and N. E. Green, NBS Research Associates sponsored by the Manufacturing Chemists' Association, in cooperation with the plastics manufacturers.



Typical results obtained for the outdoor performance of plastics show 3 identical specimens exposed in Arizona, Florida, and Washington, D.C., to determine the effect of different environments on the color fastness of the plastics.

In the study 20 plastics formulated from 6 base polymers were exposed to outdoor conditions and accelerated weathering in the laboratory to evaluate their performance and establish a relationship between the two types of exposures. The base polymers were polyethylene (PE), polymethyl methacrylate (PMMA), polyvinyl fluoride (PVF), polyethylene terephthalate (PETP), glass-reinforced polyester (RP), and polyvinyl chloride (PVC). At periodic intervals, samples were removed for testing. Sufficient specimens were exposed initially to allow for up to 10 years of sampling.

A computer was used to select, plot, analyze, and correlate the data. Variables coded included type of exposure, time of exposure, type of plastic, property measured, and the value of that property.

The colors of all original and outdoor-exposed specimens were measured with a spectrophotometer to obtain CIE tristimulus color values (X, Y, and Z). These measurements were carried out under the direction of P. Giesecke of American Cyanamid Company.

Total color difference (E) was then calculated by using Reilly's modification of Glasser's cube-root formula, which is considered an improvement of the Adams chromatic-value formula.[2] An added benefit of this method of calculation is that it allows a direct comparison be-

...een the spectrophotometer readings and tristimulus ...orimeter readings.

A classification system was also developed as part the study to better evaluate the performance of plas-...s. In this system the specimens are ranked from "A" ...rough "F" depending on the highest property value ...btained for each specimen at any time within a given ...riod at any location. The system has proved quite suc-...ssful when applied to the color-difference data.

After two years of the study, discoloration "failures" (ΔE greater than 25 units) occurred only in Arizona, and only for 4 clear plastics. Two other clear plastic films failed by embrittlement in Arizona.

All of the clear PVC's followed similar patterns of discoloration. There was an initial color change that was followed by slight bleaching and then rapid discoloration. All white-pigmented PVC's showed somewhat periodic slight discoloration. Periodic discoloration did not appear strongly dependent on formulation or thickness for either clear or white PVC's.

PVF and PMMA were quite color-fast. Both materials performed equally well (class "A") and were apparently not affected by location.

In an overall perspective, it was found that most of the plastics in all locations were fairly color-fast for one year, but by two years, varying degrees of significant discoloration were measured. At two years, for example, there were 4 class "A," 9 class "B," 2 class "D," 1 class "E," and 4 class "F" plastics.

To date, most of the results evaluated in the study have been concerned with discoloration as a function of time and location. The complete study, however, includes measurements of 7 other properties. These consist of other appearance properties, as well as physical strength and electrical parameters; they will be reported in a subsequent article.

[1] For details on accelerated weathering, see Clark, J. E., and Harrison, C. W., Accelerated weathering of polymers: Radiation, J. Appl. Poly. Sci., Applied Polymers Symposia No. 4, 97–110 (1967).

[2] Billmeyer, F. W., Significance of recent CIE recommendations for color measurement, Color Engr. 6, No. 1, 36 (Jan.–Feb. 1968).

Reference Program on Paper Testing

THE UNITED STATES PULP AND PAPER industry yearly produces over 450 pounds of paper and paperboard for each individual in the country. Because of this already large and steadily growing output, accurate paper testing procedures are of major concern to the industry. It is desirable that such procedures be standardized and calibrated as even small systematic errors in test values can add considerably to the cost of manufacture.

The need for newly standardized and calibrated testing services has been recognized by pulp and paper laboratories throughout the country. A collaborative reference program, administered by the Bureau at the request of the Technical Association of the Pulp and Paper Industry (TAPPI), will attempt to fulfill this need. As administrator, NBS prepares and distributes paper samples and provides analyses of test results.

The immediate objectives of the program are twofold: (1) to provide a means whereby a participating laboratory may periodically check the level and uniformity of its testing in comparison with that of other laboratories and (2) to improve the reliability of test results both within and among laboratories.

Initially the program will deal with nine paper tests—burst, tensile, tear, pick (surface strength), air resistance, brightness, opacity, smoothness, and gloss. Each participating laboratory is committed to three or more paper tests, which it selects upon enrollment. Two different samples of paper, which have been randomly selected from uniform machine runs, are distributed bimonthly to the participants. After carrying out the number of measurements specified for each of the tests, the laboratory returns the results of its test determinations to NBS for an analysis of the data. Other information relevant to an accurate analysis is also reported, such as test conditions and the instruments used.

Having analyzed all test results, the Bureau then prepares a summary report for return to the participants the following month. The report includes test data, averages, and standard deviations for individual laboratories and for the group as a whole. Information is also provided in such a manner that an individual laboratory may readily determine the level and variability of its results in comparison with those of the other laboratories. In the test report each laboratory is identified by a code number so that the information is maintained on a confidential basis.

An annual report summarizing the data, the improvement in reliability, if any, and recommended changes in the program will be prepared by the Bureau and submitted to both the TAPPI Standards Committee and the participants.

In time, the program may be extended to provide other services, such as field inspections, calibration and repair services for test instruments, or standard reference materials for individual test procedures.

Further information on the collaborative reference program may be obtained from Dr. T. W. Lashof, Polymers Building, NBS, Washington, D.C. 20234.

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Ultrapure Aluminum Produced

A Cooperative Effort between the Bureau and private industry has resulted in the production of the highest purity aluminum in the United States, and probably the world.

This high-purity aluminum, with an impurity content of less than about 0.2 parts per million, was prepared under the auspices of a program directed by V. D. Arp, M. B. Kasen, and R. P. Reed of the NBS Cryogenics Division in Boulder, Colo. Sponsors of the program are the Department of the Army and the Department of the Air Force.

Interest in high-purity aluminum stems from the fact that, at very low temperatures, it is an extremely good conductor of electricity. Thus, it has a high potential for use in large cryogenic-magnet devices employed in accelerators, bubble chambers, and magnetohydrodynamic applications where, in some situations, superconductors would be economically unfeasible. For example, cryogenic aluminum magnets would appear to be more attractive than superconductors in some applications where the device is turned on and off frequently. The purity of the aluminum for use in cryogenic magnetic devices is of paramount importance, since the electrical resistance of a pure metallic element at very low temperatures is greatly increased by minor impurities.

The objectives of the Bureau's high-purity aluminum program were twofold. The first objective was to make an extensive study of the properties of aluminum to provide background information for the design of large cryogenic aluminum magnets. This study has included an investigation of grain size, stress, impurity, and electrical resistivity.

The second objective was to survey the metallurgical industry to determine what was already available from suppliers of high-purity aluminum, and then to encourage further development leading to substantial improvements. Initially, the purest aluminum that could reliably be obtained in commercial quantities had a resistivity ratio* of about 2000, corresponding to an impurity content of several ppm (parts per million). Major improvements were made through contracts and cooperative programs with industry to prepare aluminum of maximum purity. NBS scientists conducted many tests on industrial samples to determine electrical resistivity and chemical composition. Through this program 15 000-ratio aluminum became available in single ingots weighing 20 kilograms or more. These were prepared by a zone-refining technique.

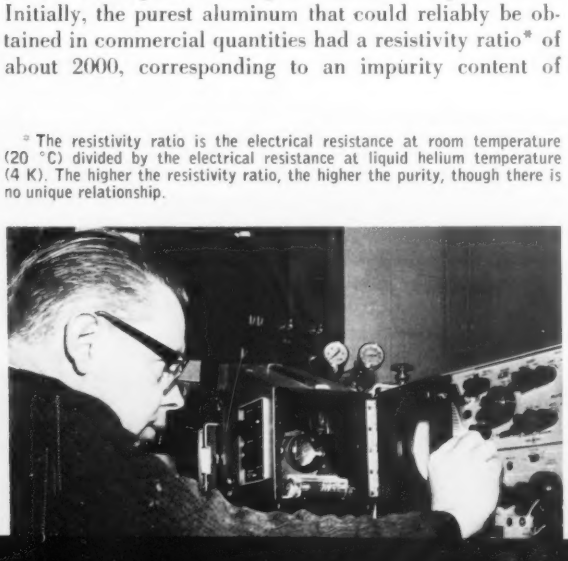
To obtain aluminum of the greatest purity and the highest resistivity ratio, two refining techniques were used in series. First, NBS scientists obtained a supply of "organically refined" aluminum from a European supplier. This aluminum, with a resistivity ratio of about 8000, was prepared by a very hazardous process involving the electrolytic reduction of aluminum triethylene. The organically refined aluminum was then further purified by a U.S. firm by means of a zone-refining technique. The end result is the highest purity aluminum on record, as exhibited by a resistivity ratio of 45 000, corresponding to a total impurity content of less than about 0.2 ppm. The availability of the organically refined aluminum is extremely limited, so that only about a kilogram of the 45 000-ratio material has been prepared to date.

In addition to its potential utilization in large cryogenic magnet devices, this extremely pure aluminum is also under consideration as an NBS Standard Reference Material. Its melting point and superconducting transition temperature offer excellent fixed points for thermometry work. In fact, its superconducting transition temperature is probably the most sharply defined such temperature known. Also, because of its purity, there is expected to be no variation in these temperature points among ingots of different batches; hence, no specific calibration work would be required.

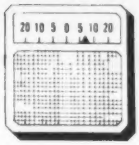
The 15 000-ratio aluminum also promises to be of value as a Standard Reference Material. Because of the extremely large grain size, averaging about 5 cm, well-characterized single crystals cut from this material may become available for research purposes. Standard Reference Materials are disseminated by the Bureau to industrial and research laboratories for use in calibrating or evaluating analytical equipment and measurement systems.

At the present time, 15 000-ratio aluminum is commercially available in reasonable quantity for scientific and technological use. The 45 000-ratio aluminum is in very limited supply, although technological demand could result in its production on a commercial basis.

* The resistivity ratio is the electrical resistance at room temperature (20 °C) divided by the electrical resistance at liquid helium temperature (4 K). The higher the resistivity ratio, the higher the purity, though there is no unique relationship.



M. B. Kasen determines the residual resistivity in superpurity aluminum at liquid helium temperature (4 K) by observing the rate of decay of eddy currents generated within the specimen.



STANDARDS AND CALIBRATION

COMMERCIAL TELEVISION AIDS NBS STANDARD BROADCASTS

In a continuing effort to upgrade the accuracy and precision of NBS time and frequency broadcasts, Bureau scientists and engineers have borrowed from commercial television in Denver, Colo., and from Czechoslovakian know-how.

Television broadcasts from Denver TV stations are now a key element in the chain of controls for precision and accuracy of the Nation's time and frequency broadcasts. With this new system the clock that controls the broadcasts from station WWV in Fort Collins, Colo., may be kept within a millionth of a second of the atomic clock in Boulder.

In the new U.S. technique a television synchronizing pulse on the TV carrier wave is used. The system was adapted from a Czechoslovakian experiment [1] and put into operation by John Milton, electronics engineer in the Bureau's Frequency and Time Broadcast Services Section in Boulder, which operates four NBS radio stations.

The system works this way. A commercial TV set is operated at the NBS atomic-clock end in Boulder, and another at the NBS broadcast-station end in Fort Collins. Both TV sets are tuned to the same Denver TV channel, so that they both receive the same program. TV signals (the "program") are carried by a very high frequency radio wave called a "carrier wave."

Both TV sets are connected to sensitive electronic equipment which records the arrival of periodic pulses on the carrier wave. The "synch pulses" are a known distance apart and are easily identified by electronic devices which "tag" them as they arrive at the location of each recording device. In the present case, the distance from crest to crest of succeeding pulses is about 11.8 miles.

The sensitive equipment records the time of arrival of these pulses at the "atomic clock" in Boulder and at the radio stations in Fort Collins. The time delay between the TV transmitter near Denver and the Boulder and Fort Collins receivers is accurately known to a tenth of a millionth of a second. From this information NBS scientists calculate the time difference between two clocks—the atomic-clock at Boulder and the one at Fort Collins which controls the radio broadcasts. Once the difference is known, even if it is only a few millionths of a second, corrections may be made to synchronize the Fort Collins radio station clock with the atomic clock in Boulder.

The absolute accuracy of the measurement is conservatively set at plus or minus a millionth of a second, but the day-to-day precision often approaches plus or minus one-tenth of a millionth of a second.

This is the most accurate synchronization system yet employed by the Bureau in Boulder (or by anyone else so far as is known). However, further research is being conducted to provide an even more accurate system for keeping NBS time and frequency broadcasts as close to the atomic clock as possible.

THREE STATES RECEIVE WEIGHTS AND MEASURES STANDARDS

North Carolina, Pennsylvania, and Wisconsin became the latest States to receive new sets of weights and measures standards under a program to replace the standards of all 50 States. The sets include standards of both the customary and metric measurement systems.

On February 25, A. V. Astin, NBS Director, presented a set to Governor Robert W. Scott of North Carolina in a ceremony at the State Weights and Measures Laboratory in Raleigh. Dr. Astin presented another set on March 3 to Governor Raymond P. Shafer at the Pennsylvania State Weights and Measures Laboratory in Harrisburg. On March 7, L. M. Kushner, NBS Deputy Director, presented a set to Wisconsin Governor Warren P. Knowles at the State Weights and Measures Laboratory in Madison.

CALIBRATION FEES RISE IN JULY

Because of increasing costs of operation, calibration work completed after June 30, 1969, will be invoiced at fees approximately ten percent higher than those quoted for current work. A revision of the Fee List, Part 8 of NBS Special Publication 250, *Calibration and Test Services of the National Bureau of Standards,* will appear in July, effective on work completed after date of issuance.

NBS Special Publication 250 (1968 edition, with revisions to date) is available at $1.75 per copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. By returning the postcard accompanying each copy of SP 250, the purchaser can be placed on the mailing list to receive, without cost and as they are issued, copies of the *NBS Measurement Users Bulletin.* The *Bulletin* provides informal news about calibration and test services, a check list of changes in the services, and, when necessary, inserts that supplement or replace portions of SP 250.

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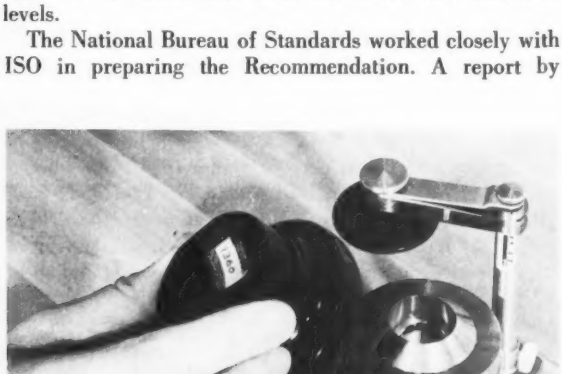
International Standard Reference Zero for Audiom

AUDIOMETERS, INSTRUMENTS FOR MEASURING HEARING acuity by determining response to accurately known tones, are calibrated for use in terms of the threshold level for hearing. The United States has had two audiometer zero standards since 1964, when the International Standards Organization (ISO) issued Recommendation R389, giving new zero values for the air conduction threshold of hearing. The previous standard, specified in USA Standard Z24.5–1951 of the USA Standards Institute (USASI), used data from a National Health Survey conducted by the U.S. Public Health Service in 1935–1936. The ISO Recommendation is based on hearing threshold measurements made in five participating countries—U.S.A., U.K., U.S.S.R., France, and West Germany—and on data obtained in an interchange of earphones used by these countries. It has been accepted by the American Academy of Ophthalmology and Otolaryngology and by the American Speech and Hearing Association, but USASI has not yet revised its 1951 standard to conform to the ISO Recommendation. This is in part because of dissatisfaction with the lower ISO reference levels.

The National Bureau of Standards worked closely with ISO in preparing the Recommendation. A report by Pearl G. Weissler of the NBS sound laboratory staff, containing an analysis of the data by NBS staff members, fills a present need.[1] In general, the findings are that the estimated average standard deviation of the ISO reference levels is 2 dB; the present USASI standards are definitely outside the ISO uncertainty limits; and the precision of the reference level would be significantly increased if there were one standard earphone type. Also, national and international comparison problems would be greatly reduced if all hearing threshold measurements were made with the same type of earphone.



An earphone to be calibrated is placed atop a coupler. The upright in the background is for seating the earphone with a specified force.

Calibrating Audiometers

Audiometer signals are described in terms relative to the smallest amplitude of sound pressure audible at that frequency. An audiometer could be calibrated from one person's hearing by noting the smallest earphone voltage at which the subject reports audibility at each frequency. However, individuals differ so greatly that a fixed threshold level is used. The earphone voltage at threshold is measured for a large number of people with normal hearing in order to establish a mean threshold.

The threshold determination is put on an objective basis by transferring the earphone emitting the threshold tone from the subject's ear to a coupler—an "artificial ear"—and measuring the sound level within the coupler. A coupler is a cavity of predetermined shape and volume simulating the ear. It is usually machined of metal and has a surface against which the earphone rests. It is terminated by a calibrated microphone. The microphone measures the sound pressure developed in the cavity by the earphone. A variety of couplers are in use in different laboratories and the standards of only two of the countries (U.S.A. and West Germany) are obtained with the same coupler. None use the same earphone as national standards.

Earphone Intercomparisons

The value obtained for an equivalent threshold sound pressure level (ETSPL) is dependent on the electroacoustical properties of the earphone and coupler types used. Because different earphone-coupler combinations were used by the countries contributing ETSPL data, the ISO

Pearl Weissler determines the response of the audiometer earphone on the coupler atop a preamplifier unit.

could not compare the sets of ETSPL values directly. It therefore conducted a systematic side-by-side comparison of the outputs of the exchanged earphones, from which it obtained factors for converting sound level indications of any earphone-coupler combination to those of another combination of this group.

The countries were considered to be arranged in a ring, each member of which made subjective loudness-balancing or objective comparisons of its own and its neighbors' earphones. Thus the United States exchanged earphones with the British and determined the input voltage levels of the British STC 4026–A and the United States' WE 705A earphones, both set to produce the same sound pressure in real ears as measured on test subjects. The British meanwhile performed a similar comparison of input voltage levels with both earphones set at a level adjudged equally loud by their test subjects. The earphones were then placed on their own national couplers and sound levels within the couplers corresponding to the measured input voltages were determined. The differences in sound pressure for the two earphone-coupler combinations provided the preliminary transfer factor. Following this, the United States made a similar exchange with its other neighbor in the ring, the U.S.S.R.; both performed comparisons of the WE 705A and the Russian TD–6 earphones to obtain another transfer factor.

ISO Recommendation

The transfer data obtained by the earphone interchange were used by Richard K. Cook, then at NBS, in computing factors for converting a threshold measurement to its equivalent value for another earphone-coupler combination. This was done by summing up the "ring" of reported transfer factors, which should equal zero, and distributing the residual error among the individual transfer factors.

The ISO Working Group then studied how to weight the differing threshold determinations to obtain a representative international value. It was felt that the differences represented equipment and experimenter error, rather than statistical error due to the number of subjects used; the weighting method selected was designed to balance these types of bias. The resulting values are given in ISO Recommendation R389. It is interesting to note that other variations of the weighting method used would also have yielded virtually the same values.

Statistical Analysis

Statistical analysis, performed by a procedure developed by Joan Rosenblatt of the NBS Statistical Engineering Section, yielded an average estimated value of 2 dB for the standard deviation of the ISO reference zero values. There is a systematic difference between the ISO and the USASI reference values which is appreciably greater than 2 dB at all frequencies.

Systematic and other interlaboratory differences manifested themselves in the differences among threshold determinations performed by different laboratories; even with similar equipment the variance was greater than could be expected for the numbers of subjects used.

The 2 dB standard deviation of the ISO reference zero results in part, also, from error introduced by the transfer factors. If the participating countries had used the same type of earphone and thereby eliminated the need for transfer factors, the standard deviation of the reference zero might be as little as 0.7 dB. For this reason it is recommended that the countries agree on a single type of standard earphone.

The configuration of couplers used in earphone comparisons is important also, and any earphone proposed for use should be examined for compatibility with the coupler with which it would be used.

[1] Weissler, Pearl G., International standard reference zero for audiometers, J. Acoust. Soc. Am. **44**, No. 1, 264–275 (July 1968).

Note: Among the acoustic calibrations performed at the National Bureau of Standards is the calibration of earphones used for audiometry. This and other calibration services available are described in: **Calibration and Test Services of the National Bureau of Standards**, Special Publication 250 (1968 edition, $1.75). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

NSRDS Compilation Activities

Data compilation is the major activity of NSRDS and involves many scientific disciplines and organizations including those of the Federal Government, education, and industry. Much of this activity is centered in the National Bureau of Standards' technical divisions where many of the NSRDS data compilations are conducted. Other NSRDS compilations are carried out in universities, and in some cases in private industrial organizations. Some of these projects are funded solely by NBS through its Office of Standard Reference Data, others are funded jointly by NBS and other Federal agencies. A few are funded by other Federal agencies with monitor responsibility delegated to the Office of Standard Reference Data. A number of projects funded by other Federal agencies are considered to be part of NSRDS because the output is of appropriate nature.

The level of effort in each project supported by the Office of Standard Reference Data is determined by a practical compromise involving three considerations: The degree of *comprehensiveness* of the literature review, the procedure for *critical evaluation* applied to the data, and the need for *continuity* in updating the compilations. These considerations require further discussion.

Comprehensiveness. The raw material for any data compilation project is the result of measurements made by scientists in any part of the world. The majority of these results are reported in the literature, including some journals that may be obscure or difficult to obtain. However, an increasing fraction of results worth saving for posterity is now appearing in government reports. Furthermore, in some areas (one example is data on neutron cross sections) many of the data generated in the laboratory never appear in any report or publication; in such instances the compiler personally may have to pry the data from the measurer. Therefore, the degree of comprehensiveness that can be achieved must be a practical compromise between the desired 100 percent and the cost in time, money, and effort required to achieve that goal. For most existing projects the comprehensiveness probably attains 90 to 99.8 percent.

Critical evaluation. The procedure for critical evaluation varies widely from project to project. In present practice at some data centers, the experimental technique is reviewed, calculations are spot-checked, values of the fundamental constants are checked to ensure that the latest values were used, the temperature scale and other bases of measurement are checked (if appropriate), and limits of experimental uncertainty are independently assessed. In other centers, the data evaluator may decide, for intangible reasons that he may find difficult to formulate, that one particular value in the literature is "better" than another value. Such a judgment by a specialist of broad experience should not be underrated; the value obtained is more likely to be accurate than the result of unweighted averaging. Most people agree that the first procedure provides a better critical evaluation than the second. However, for the practical purposes to which many compilations are applied, such a review is not justified, and the second procedure, or an intermediate one, is employed.

Continuity. For each individual compilation project, requirements for continuity must be examined. The overall program of NSRDS is designed to ensure continuity of effort in production of data compilations needed by scientists and engineers. In some areas a revised and updated compilation may be needed every 6 months; in others, only every 4 or 5 years. In almost all areas, continuing literature review and indexing operations are required to maintain a current awareness of the state of development of the field. Therefore, most projects undertaken by NSRDS are expected to be long term, continuing activities, maintained as one component of the project leader's normal range of professional activity.

Ionization of Atoms by Electron Impact

Theory of the Ionization of Atoms by Electron Impact,[2] by M. R. H. Rudge of the School of Physics and Applied Mathematics, The Queens University of Belfast, Northern

Ireland, is a review of available theoretical procedures of ionizing atoms by electron impact. This review was sponsored by the JILA Information Center, University of Colorado, Boulder, which is supported by the NBS Office of Standard Reference Data and by the Advanced Research Projects Agency of the U.S. Department of Defense.

In recent years, a substantial amount of experimental and theoretical work has been devoted to the study of ionization cross sections of atoms or ions by electron impact. The importance of an accurate evaluation of these cross sections is evidenced by the wide variety of physical phenomena, the interpretations of which demand a knowledge of reaction rates for ionization by electron impact. Examples of such phenomena arise in the study of plasma physics, stellar atmospheres and solar corona, gas discharges, and the passage of shock waves through gases. Much progress in obtaining an accurate knowledge of ionization cross sections has been made recently by a variety of approaches. Substantial experimental work has been performed in which single- or multiple-ionization cross sections of atoms and ions from ground states have been measured. This was the subject of an NSRDS-sponsored review by L. J. Kieffer and G. H. Dunn.[1]

The available experimental data are far from exhaustive. Many species remain to be investigated and there are difficulties in the experimental determination of ionization cross sections from excited states. Recourse in these cases has been made to theoretical studies.

On the theoretical side, the basic formulation of the problem has received a good deal of attention, and the theory of ionizing collisions was found to differ quite markedly from that of collisions involving excitations. At the same time, a number of new approximate quantal methods of treating the problem have been investigated. Even so, quantal calculations are lengthy and not yet as accurate as could be wished. Alternative approaches have been pursued with the aim of providing reasonably accurate estimates in a very simple fashion. Such approaches arise through the use of a classical rather than a quantal theory of collisions and from devising semiempirical formulas that represent known data and may be used, with suitably defined parameters, to estimate as yet unmeasured or uncalculated data.

In his review, Dr. Rudge places particular emphasis on the most salient features of the basic formulation and deficiencies in approximate methods. He offers a discussion of quantal and classical approximations, and their predictions are compared with experimental data. The review also lists and compares useful empirical formulas. In conclusion, it notes the inadequacies in present theory.

Optical Atomic Spectra ^{24}Cr–^{41}Nb

The three published volumes on *Atomic Energy Levels*, NBS Circ. 467, contain for each spectrum the bibliography that was used in compiling the data. A continuation of these bibliographies arranged in the same form is underway.

Bibliography on the Analyses of Optical Atomic Spectra, NBS Spec. Publ. 306, is being published by sections and covers the same elements as the respective volume of NBS Circ. 467. Section 1[3] ($1) was issued in September 1968; it contains references for the elements ^{1}H through ^{23}V, corresponding to *Atomic Energy Levels*, Volume I.

The recently published Section 2[3] (60 cents) is similarly arranged, giving references to the spectra of the elements ^{24}Cr through ^{41}Nb, corresponding to *Atomic Energy Levels*, Volume II. For a given element the spectra are listed in order of increasing stage of ionization. The new publication spans the time interval between the earlier publications and the present. The selection of references is restricted to those needed for the preparation of revised tables of atomic energy levels and multiplets. The original papers have been examined for nearly all of the quoted references.

Electronic and Atomic Collisions From Russian Literature

The Atomic and Molecular Processes Information Center, an NSRDS-associated center at Oak Ridge National Laboratory, has recently released *Electronic and Atomic Collision Bibliography of Russian Literature for the Years 1946–1966*.[4] This bibliography was compiled by the scientific staff of the Physico-Technical Library of the A. F. Ioffe Institute, Leningrad. The bibliography was translated by Donna M. Cobble from a Russian edition, provided and edited by Professor V. M. Dukel'skii. The original Russian references are retained and translated references have been added for those items that have been printed in English. The bibliography is arranged by major categories. The numerical order of the entries is unchanged from the original Russian bibliography. An author index is included.

COSATI Directory To Be Revised

The Panel on Information Analysis Centers of the Committee of Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology is in the process of updating and revising the *Directory of Federally Supported Information Analysis Centers*. Previously listed centers as well as others which receive full or partial support from the Federal Government are in the process of being surveyed as to their appropriateness for inclusion. The criteria for inclusion of a Federally supported center in the Directory are:

1. The key activities are the analysis and interpretation, synthesis, evaluation, and repackaging of information for the purpose of enabling users to better assimilate information or numerical data of a specific field.
2. An Information Analysis Center uses subject specialists to perform the analysis, evaluation, or synthesis.

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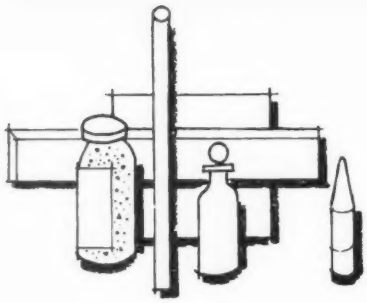
STANDARD REFERENCE MATERIALS



Standard Reference Materials are well-characterized materials certified for chemical composition or for a particular physical or chemical property. These materials are disseminated by NBS [1] to be used to calibrate and evaluate measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base.

Neutron Density Monitor Wire

The accurate determination of thermal neutron densities is essential in irradiation tests in obtaining a basis for comparison of neutron densities among reactors, in applying data in the design of reactors, and in understanding the mechanism of radiation damage. Cobalt alloys, particularly 0.1 weight percent cobalt in aluminum, have been widely used to measure thermal neutron densities in almost all irradiation experiments on materials. Of increasing major importance, however, has been the need for a material of the highest possible homogeneity for which an accurate determination of the cobalt content is provided.

A new standard, SRM 953, Neutron Density Monitor Wire, was designed to meet these needs. It will also prove useful to the activation analyst for mapping relative variations in neutron densities along the length and width of irradiation containers, for determining the integrated neutron flux density (insofar as small lengths approximate a sphere), and for determining long term variations of the neutron density at given irradiation positions. For most applications, these measurements will be made on a relative rather than an absolute basis.

SRM 953 is a cobalt-in-aluminum wire 0.5 mm in diameter, which was prepared, using specially selected high-purity starting materials, by the Materials Research Corp., Orangeburg, N.Y. Based on results obtained at NBS by activation analysis and spectrophotometric analysis, the cobalt content is certified at 0.1164 weight percent.

Extensive homogeneity testing of the wire was performed by a variety of methods at the National Bureau of Standards' laboratories in Gaithersburg, Md., and Boulder, Colo. The wire material selected for certification was found to be homogeneous for sample lengths of 1 mm or longer.

The wire has been certified with the error of the cobalt value estimated to be less than 0.0023 weight percent.

This standard, SRM 953, will normally be sold in units 1 meter long for $30 per unit.[2] However, upon special request to the NBS Office of Standard Reference Materials, it may be purchased in continuous lengths that are multiples of one meter for $30 per meter.

Basic Oxygen Furnace Steel

The plain carbon steel grades were the first of what are now Standard Reference Materials to be certified by the National Bureau of Standards. These included steels produced by the acid Bessemer, the acid open-hearth, and the basic open-hearth furnace processes. A strong demand for these standards has existed for a period of more than 60 years, and has increased rapidly in recent years. The more stringent chemical composition specifications in the steel industry and new, more rapid kinds of analytical equipment that rely on comparison techniques with standards of known composition are responsible for this demand. Furthermore, the demand is expected to grow with the continuing growth in use of both the basic oxygen furnace and the continuous casting processes of steel manufacture. These relatively new commercial processes place urgent demands on the analytical laboratory for data within the very short elapsed time from sampling to reporting of the final analysis.

The primary consideration in preparing steel standard reference materials is the resultant chemical composition of the steel, not the method by which the steel is produced. This is fortunate, for in the United States the acid open-hearth process is no longer used commercially, the use of the acid Bessemer process is rapidly diminishing, and the basic open hearth is being superseded or supplemented by basic oxygen furnaces. In the near future, steel for preparing renewal standards of the plain carbon steels may be available most readily from the basic oxygen furnace process.

The new SRM 178, chip form, carbon steel, is the first steel made by this basic oxygen furnace process to be certified. It was prepared by the Armco Steel Corp., and is intended for the same uses for which SRM 20f, Acid Open Hearth Steel, was used. Analyses for certification

were performed at NBS by J. R. Baldwin, E. R. Deardorff, S. A. Wicks, B. A. Thompson, T. Gills, and D. A. Becker. The Army Materials and Mechanics Research Center, Watertown, Mass.; Allegheny-Ludlum Steel Corp., Brackenbridge, Pa.; Inland Steel Co., East Chicago, Ind.; and Bethlehem Steel Corp., Sparrows Point, Md., also provided cooperative analyses. The overall direction of the technical measurements leading to the certification was performed under the chairmanship of O. Menis and J. I. Shultz of the NBS Analytical Chemistry Division.

The new SRM is issued with a Provisional Certificate of Analysis giving the present best estimates of the values for carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, vanadium, and molybdenum. SRM 178 is sold in units of approximately 150 grams for $28 per unit.[2]

Radioactivity SRM's

Four radioactivity standards not previously announced were certified and issued during the past year. They are discussed below. These standards were prepared and calibrated in the Center for Radiation Research, Nuclear Radiation Division, by members of the Radioactivity Section under the direction of W. B. Mann.

All the error limits quoted are discussed and their various components listed in detail on the certificates supplied with each SRM.

Tin-113–Indium-113m

The standard consists of tin-113 in equilibrium with its daughter product, indium-113m, in 5.279 $\pm$0.009 g of solution in a sealed ampoule. The chemical form of the material is $SnCl_4$ in 2.5 N HCl. At 0800 EST on April 15, 1968, the number of indium-113m gamma rays emitted per second per gram was $1.39 \times 10^5 \pm 2.1_7$ percent. The solution from which the standard was prepared was standardized by photopeak—scintillation counting using both NaI(Tl) and Ge(Li) spectrometers. The price of this SRM is $85.[2]

Radium-226

This standard, developed primarily for radon analysis, consists of 20.598 $\pm$0.017 g of a solution of radium-226 and 0.2 weight percent carrier solution of barium chloride in hydrochloric acid. In March 1968 the weight of radium-226, in grams, in the sealed ampoule was $8.08_3 \times 10^{-9} \pm 1.0_0$ percent.

This standard was prepared from a dilution of a solution which had been calibrated by comparing its gamma-ray-emission rate with those of a 1957 series of standards. The 1957 series was prepared from material that had been compared, in the National Bureau of Standards radiation balance, with the national radium standards. The dilution has been verified by radon analysis. The price of this SRM is $76.[2]

Thorium-228–Thallium-208

This standard consists of thorium-228, in equilibrium with its daughters, deposited as the nitrate on 0.019 cm-thick gold foil to which was cemented another layer of similar gold foil. The gold-covered source is sandwiched between two double layers of 0.036 cm-thick polyurethane film.

In August 1968 the approximate number of 2.615 MeV gamma rays of thallium-208 emitted per second was 4×10^4. The actual certified value, given on the Certificate, is known to $\pm 2.2_0$ percent.

This standard was calibrated by comparing its gamma-ray-emission rate, in a reproducible geometry, with that of an NBS working standard of thorium-228. The working standard had been calibrated by comparing it, through alpha-ray emission-rate measurements, with a polonium-210 standard.

SRM 4205 is priced at $93 for each point-source.[2]

Plutonium-238

This standard consists of a practically weightless source of plutonium-238 electroplated onto a 0.010 cm-thick platinum foil which is cemented to a monel disk 2.5 cm in diameter and 0.16 cm thick.

When measured in the National Bureau of Standards $2\pi\alpha$ proportional counter above an energy-discrimination level of 400 keV, the number of alpha particles emitted per second from the source into the forward hemisphere, including those backscattered, was found to be (in 1968) nominally $2 \times 10^3 \pm 1.0$ percent. The actual rate is, of course, supplied on the certificate. The price of this SRM is $78.[2]

Renewal SRM's

From time to time it is necessary to renew SRM's as stocks are depleted. When no major changes in the certified properties are made, the renewal SRM is given the same SRM number as its predecessor, changing only the letter following. For example, SRM 1069b is the second renewal of 1069.

The following renewal SRM's have not been previously announced:

SRM	*Name*	*Price per unit*
372g	Stearic acid	$26
385b	Natural rubber	100
388e	Butyl rubber	100
1069b	Sodium cyclohexanebutyrate	26

[1] For a complete list of Standard Reference Materials available from NBS, see Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards, NBS Misc. Publ. 260 (1968 ed.) for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents. Quarterly insert sheets which update Misc. Publ. 260 supplied to users on request.

[2] These standards may be purchased for the price indicated from the Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

FIPS NOTES

In the fall of 1965 the Secretary of Commerce established the NBS Center for Computer Sciences and Technology to carry out the Secretary's responsibilities under the Brooks Bill (Public Law 89–306, passed October 30, 1965). The Center, under the direction of H. R. J. Grosch, provides leadership and coordination for government efforts in the development of voluntary commercial information processing standards, develops recommendations for Federal information processing standards, performs required research and analysis, and provides scientific and technical support and consultative assistance in the field of computers and information processing to Federal agencies. These Notes will cover information-processing standards activities in the Federal Government, particularly those of the Center.

NEW REFERENCE TAPE STANDARD

Amplitude-reference magnetic computer tapes have recently been developed by Paul Mantek and Sidney Geller of the NBS Center for Computer Sciences and Technology and Norman Cleveland, an NBS Research Associate sponsored by the International Business Machines Corp. This work was undertaken at the request of both national and international magnetic-tape standards bodies.

These tapes are being made available to the information-processing community as Standard Reference Materials by the NBS Office of Standard Reference Materials. As secondary standards they will be used internationally as a reference in the manufacture of magnetic tapes used in computer tape recording and reproducing devices.

The present characteristics of magnetic computer tapes stem from the lengthy research and development in commercial magnetic tapes and tape read-write products. Such research and development have resulted in continued improvement of the tape medium and its performance. Unfortunately, the only reference tapes available for quality assurance purposes have been individual company standards. Because of this, differences in tape characteristics and marginal operation have often occurred when tapes were interchanged between systems and between equipments.

This lack of industry-wide standards, as well as requests from Federal procurement agencies, industrial users, and producers of magnetic computer tapes or associated equipment, led the Bureau to develop tape measurement methods to make available a standard magnetic tape for computer amplitude reference. This new standard is NBS Standard Reference Material 3200, Secondary Standard Magnetic Tape—Computer Amplitude Reference, and consists of a 600-foot reel of tape, applicable test and calibration data, and a description of the equipment and procedures employed for measurement of the standard. The standards themselves are ½ inch wide unrecorded magnetic tape wound on 8½ inch diameter precision reels. (Magnetic computer tape normally consists of oriented ferromagnetic oxide particles dispersed in a suitable polymeric binder material that has been uniformly coated over the surface of a flexible polyester or equivalent base material.)

Each unit of SRM 3200 will be calibrated with reference to the NBS Master Standard Magnetic Tape—Computer Amplitude Reference. The signal level calibration of the standard tapes is made at recording densities of 200, 556, 800, and 3200 flux reversals per inch, and calibration information in the form of signal output charts recorded near the edges and at the center of the tape accompany each sample. A set of saturation curves relating the reproduce head output voltage on the first read-after-write pass to the write current at each bit density will also be included with the material. The price of SRM 3200 is $690 per unit.[1]

One criterion of the secondary reference tape is that there be no more than a 4 percent variation in signal output along any longitudinal track on the total 600-foot length of any tape surface when that tape is recorded by the user at the saturation current level. Another criterion is that the absolute output of the reference tape be within 10 percent of the NBS Master Standard Magnetic Tape—Computer Amplitude Reference, as measured on the NBS signal amplitude calibration system.

The General Services Administration will use these secondary tape standards for calibration of qualification test equipment. Procurement specifications will be revised to reflect this new procedure. In addition, references in present and pending USASI or ISO standards documents to a reference tape are being revised to cite the new NBS standard.

DISK PACK REFERENCE STANDARD

A program similar to the one that resulted in the development of the magnetic tape reference standard has recently been started with the goal of developing a mag-

ne c disk pack reference standard. USASI Committee X3 2.7 on Magnetic Disk Media has requested the Bureau to hold the current industry standard, an IBM Reference Master Disk, in repository for use as a national magnetic disk amplitude reference. The Bureau and the International Business Machines Corp. have agreed to a study that will define and develop a program for the use of the magnetic disk reference.

Committee X3.2.7 is pursuing the two available alternatives for specifying a suitable reference surface—the development of a mathematical model, and the use of a designated physical component. The Committee feels that steps should be taken to implement the physical component solution without waiting for a successful completion of the mathematical approach. Progress in this important program will be reported as it becomes available.

NOTES ON USASI COMMITTEE Z39

The following notes are presented as part of the Center's responsibility in keeping the Federal information processing community abreast of activities in the field of voluntary standards dealing with computers and information processing.

Standards for Library Work and Documentation*

National standards for the automatic processing of bibliographic information and for periodical title abbreviations are nearing approval. Also, a dozen other draft standards that will aid librarians, information processors, and the publishing industry are advancing toward completion. This report comes from USA Standards Committee Z39, Library Work, Documentation, and Related Publishing Practices, which met in Washington, D.C., on January 28.

A draft on format for communication of bibliographic information in digital form is in the final stages and is expected to be submitted in the near future to the USA Standards Institute for approval.

A proposed revision of USA Standard for Periodical Title Abbreviations, Z39.5–1963, was submitted to letter ballot of the Z39 Committee in late January.

During 1969, the committee is expected to vote on draft standards for bibliographic references, library directories, and book publishers advertising. The latter is expected to consist of a checklist of some 20 bibliographic information items suggested for inclusion in promotion media, such as periodical, newspaper, and direct mail advertising, and jacket and catalog copy.

Other subcommittees of Z39 are working on drafts on proof corrections, book numbering, abstracts, filing, bookbinding, serial coding, title leaves of a book, and transliteration.

*Reprinted from USASI Reporter 3, No. 4, 4 (Feb. 14, 1969), with permission of the United States of America Standards Institute.

Three standards prepared by Z39 subcommittees and approved by the parent committee and USASI are scheduled for publication in the next few weeks. They deal with compiling library statistics, compiling book publishing statistics, and indexing.

Chaired by Jerrold Orne, librarian, University of North Carolina, the committee also develops the U.S. viewpoint for the international work of ISO Technical Committee 46, Documentation, and ISO Technical Committee 37, Terminology (Principles and Coordination).

NEW AND CURRENT X3 STANDARDS

The following standards are in effect or have been announced by the USASI Committee X3:

X3.1–1962	Signaling Speeds for Data Transmission
X3.2–1963	Print Specifications for Magnetic Ink Character Recognition
X3.3–1963	Bank Check Specifications for Magnetic Ink Character Recognition
X3.4–1968	Code for Information Interchange (FIPS 1)
X3.5–1968	Flowchart Symbols and Their Usage in Information Processing
X3.6–1965	Perforated Tape Code for Information Interchange (FIPS 2)
X3.9–1966	FORTRAN
X3.10–1966	Basic FORTRAN
X3.11–1966	Specifications for General Purpose Paper Cards for Information Processing
X3.12–1966	Vocabulary for Information Processing
X3.13–1966	Parallel Signaling Speeds for Data Transmission
X3.14–1969	Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)
X3.15–1966	Bit Sequencing of the USA Standard Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16–1966	Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the USA Standard Code for Information Interchange
X3.17–1966	Character Set for Optical Character Recognition
X3.18–1967	One-Inch Perforated Paper Tape for Information Interchange
X3.19–1967	Eleven-Sixteenths Inch Perforated Paper Tape
X3.20–1967	Take-Up Reels for One-Inch Perforated Tape for Information Interchange
X3.21–1967	Rectangular Holes in Twelve-Row Punched Cards
X3.22–1967	Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI) (FIPS 3)
X3.23–1968	COBOL (Number assigned pending resolution of relevant publication problems)
X3.24–1968	Signal Quality at Interface Between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission
X3.25–1968	Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication
X3.26–1969	Hollerith Punched Card Code

Copies of USA Standards are available from the United States of America Standards Institute, 10 East 40th St., New York, N.Y. 10016.

STATUS OF FEDERAL INFORMATION PROCESSING STANDARDS RECOMMENDATIONS

First Phase: PROJECT NOMINATION
Signaling Speeds for Data Transmission (X3.1–1962)

FIPS NOTES *continued*

Specifications for General Purpose Paper Cards for Information Processing (X3.11–1966)
Parallel Signaling Speeds for Data Transmission (X3.13–1966)
Time Sharing and Remote Console Considerations
Hardware Interfaces
Keyboard Configuration
Synchronous Signaling Speeds

Second Phase: STANDARDS DEVELOPMENT
Vocabularly for Information Processing (X3.12–1966)
Interchangeable Magnetic Disk Media
RFP, RFQ, and Contract Formats
OCR Measurement Technology
OCR Paper
ADP Systems Site Preparation
Magnetic Tape Labels for Information Interchange
Hollerith Punched Card Code (X3.26–1969)
FORTRAN Standard Reference (X3.9–1966, X3.10–1966)
COBOL Programing Language (X3.23–1968)
Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI) (X3.14–1969)
Character Sets for OCR Input (X3.17–1966)
Layout of Forms for OCR Input
Bit Sequencing of the USA Standard Code for Information Interchange in Serial-by-Bit Data Transmission (X3.15–1966)
Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the USA Standard Code for Information Interchange (X3.16–1966)
Signal Quality at Interface Between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission (X3.24–1966)
Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication (X3.25–1968)

Third Phase: RECOMMENDATION FOR ADOPTION
None

Fourth Phase: ISSUED FEDERAL INFORMATION PROCESSING STANDARDS
FIPS 1 Code for Information Interchange (X3.4–1968)
FIPS 2 Perforated Tape Code for Information Interchange (X3.6–1965)
FIPS 3 Recorded Magnetic Tape for Information Interchange (X3.22–1967)
FIPS 4 Calendar Date
FIPS 5 States of the United States
FIPS 6 Counties of the States of the United States
FIPS 7 Implementation of Code for Information Interchange and Related Media Standards
NBS Reference-Magnetic Computer Tape Amplitude

[1] This standard may be purchased for the price indicated from the Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

NSRDS NEWS *continued*

3. An Information Analysis Center produces new evaluated information in the form of critical reviews, state-of-the-art monographs, or data compilations and usually provides substantive, evaluated responses to queries.
4. An Information Analysis Center provides assistance to a community of users and not just assistance to "in-house" personnel.

The COSATI Panel on Information Analysis Centers is interested in hearing from centers not previously listed whose activities qualify them for listing.

Inquiries should be addressed to COSATI Panel on Information Analysis Centers, c/o Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

[1] Kieffer, L. J., and Dunn, G. H., **Electron Impact Ionization Cross-Section Data for Atoms, Atomic Ions, and Diatomic Molecules: 1. Experimental Data**, Rev. Mod. Phys. **38**, No. 1, 1–35 (Jan. 1966). (Available from the Office of Standard Reference Data.)
[2] Rudge, M. R. H., **Theory of Ionization of Atoms by Electron Impact**, Rev. Mod. Phys. **40**, No. 3, 564–590 (July 1968). (Available from the Office of Standard Reference Data.)
[3] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.
[4] Available from the Director, Atomic and Molecular Processes Information Center, Oak Ridge National Laboratory, Oak Ridge, Tenn. 37831.

STANDARDS AND CALIBRATION *continued*

STANDARD FREQUENCY AND TIME BROADCASTS

High frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. These NBS time signals, UTC (NBS), are maintained within 5 microseconds of the corresponding time signals of the U.S. Naval Observatory, UTC (USNO). The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in 10^{10} during 1969, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on June 1, 1969.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on June 1, 1969.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with which NBS maintains close cooperation.

[1] Tolman, J., Ptacek, V., Soucek, A., and Stecher, R., **Microsecond clock comparison by means of TV synchronizing pulses**, IEEE Trans. Instr. Meas. IM–16, No. 3 (Sept. 1967).

CONFERENCE & PUBLICATION *Briefs*

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

10th Symposium on Electron, Ion, and Laser Beam Technology. May 21–24. Cosponsors: University of Maryland, Institute for Electrical and Electronics Engineers (GED), American Vacuum Society. Contact: L. Marton (NBS).

Symposium on Systems Analysis for Social Problems. May 26–28. Cosponsors: Washington Operations Research Council, President's Office of Science and Technology, The Urban Institute, Operations Research Society of America (Cost-Effectiveness Section). Contact: Eugene P. Visco, GEOMET, Inc., 12280 Wilkens Ave., Rockville, Md. 20852. By invitation only.

Conference on Crystal Growth. Aug. 11–13. Sponsor: American Committee for Crystal Growth. Contact: C. S. Sahagian, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass. 01730.

Dental Research—50th Anniversary. Oct. 6–8. Cosponsor: American Dental Association. Contact: W. T. Sweeney (NBS Polymers Division).

3d Materials Research Symposium—Electronic Density of States. Nov. 3–6. Contact: H. C. Burnett (NBS Metallurgy Division).

EVALUATING LIVE FLOOR AND FIRE LOADS

Techniques for the Survey and Evaluation of Live Floor Loads and Fire Loads in Modern Office Buildings,[1] by J. O. Bryson and D. Gross, NBS Building Science Series 16 (30 pages, 40 cents), describes the procedures and techniques developed for measuring and evaluating the live floor loads and fire loads in modern office buildings. The publication also includes an outline of the main features of a computer program for analyzing the data. The program provides a tabulation of the data, some statistical properties, and selected graphical relationships between the measured loads and the characteristics and usage of the structure. A rationale is developed that is intended to achieve the ultimate goal of easier and less expensive means of surveying live loads in buildings and their combustible content. The loads were measured within two modern Government buildings in the Washington, D.C., area, and typical results are presented to illustrate the computer output.

SELECTED NBS PAPERS ON ELECTRICITY

Precision Measurement and Calibration: Electricity—Low Frequency,[1] F. L. Hermach and R. F. Dziuba, editors (489 pages, $4.50), is designated as Volume 3 of the series, NBS Special Publication 300, *Precision Measurement and Calibration*. The volume comprehensively surveys the best modern practice for basic direct-current and low-frequency measurements. It should be of interest to physicists, electrical engineers, science students, and all others concerned with accurate electrical measurements.

Each volume of SP 300 presents selected papers, monographs, abstracts, and bibliographies dealing with precision measurement of specific physical quantities and the calibration of the related metrology equipment. Volume 2, on temperature measurements, has already appeared; Volume 1, on statistical concepts and procedures, is in press. According to present plans, SP 300 will contain a total of 12 volumes.

DEVELOPMENT OF THE ELECTRON MICROSCOPE

Ladislaus L. Marton, now Consultant to the Associate Director for Information Programs and to the Chief of the NBS International Relations Office, and formerly Chief of the Bureau's Electron Physics Section, has written a short history of the critical steps leading to the successful development of the electron microscope. The book [1] is one of a series of monographs which record personal accounts of participants in major developments of modern technology.

The principle of the electron microscope seems obvious enough today. And indeed, once the wave character of the electron was demonstrated, it occurred to many that an electron-beam analog of the optical microscope could break through the resolving-power barrier set by the relatively long wavelengths of visible light. But it seemed equally obvious that the high-energy electron beams needed would burn the specimens to a crisp.

Some of the pioneers decided, therefore, to concentrate their efforts on rugged inorganic specimens that might be expected to withstand the bombardment. Dr. Marton, on the other hand (not to mention his work on the electron optical components, engineering design for greater rapid-

ity and ease of operation, and related theoretical studies of the interaction of electrons with matter), attacked the problem of adapting fragile biological specimens to the severe environment of the electron beam. His first successful electron micrographs of such specimens were greeted with disbelief by the other workers, but these doubts were soon removed.[2]

His first specimens were fairly thick, but successively thinner ones were used until he succeeded in preparing specimens, supported on collodion films, so thin the beam could pass through with almost no scattering. One of the surprises in electron microscopy was that contrast in the image was not due to absorption differences, as in optical microscopy, but to differences in scattering power. In his preface to this book, Dennis Gabor notes that Dr. Marton was the first to recognize this fact clearly. When, for very thin specimens, scattering becomes negligible, its function is taken over by phase contrast.

The best of today's magnificent instruments, the fruit of this development, have least resolved distances of a few angstroms, the order of magnitude of an atomic diameter. Capable of showing details inside a virus or within the double-helix structure of the DNA molecule, they are among the most powerful tools of medical and biological research. More recently they have been used in microchemical investigations and in microphysics, and the outlook is for continued extension of their use to all fields where microstructure can be important. It is easy to understand why Professor Gabor calls the electron microscope "the most wonderful and the most successful instrument of our times."

Dr. Marton's account is illustrated with photos and diagrams of early instruments built by himself and others and with electron micrographs that marked decisive turning points.[3] The compact text is enlivened by anecdotes and is, of course, documented by references to the original literature. There is also a short bibliography of other sources of the history of the electron microscope as well as an index.

SYMPOSIUM ON MEASUREMENT OF FLAMMABILITY

A two-day Symposium on the Measurement of Flammability, conductd by the Bureau, will be held June 5 and 6, 1969. The Symposium, broken into two working sessions each day, will be held in the Department of Commerce Auditorium, 14th Street between Constitution and E Streets NW., Washington, D.C.

Secretary of Commerce Maurice H. Stans will open the meeting. Papers for the working sessions are being invited within the context of the Flammable Fabrics Act although some of the information developed will be of general applicability. The four working sessions will be concerned with (1) Statement of the Problem, (2) What Should Be Measured, (3) State of the Art in Measurement, and (4) Applied Measurements.

Recognized experts from industry, government, and the academic world have been invited to present papers that will be published by NBS in the form of proceedings.

The General Chairman for the Symposium is James V. Ryan, Chief, Fabric Flammability Section, Rm. B06, Bldg. 225, National Bureau of Standards, Washington, D.C. 20234.

A block of rooms will be reserved for attendees at downtown Washington hotels.

[1] Marton, L., **Early History of the Electron Microscope**, San Francisco Press, Inc., San Francisco (in England: W. Heffer & Sons, Ltd., Cambridge), 1968; 56 pages; $2.75.

[2] Dr. Marton's work on the electron microscope was done in the 1930's and 1940's, first at the Universite Libre in Brussels, then in the United States at the RCA Laboratories and Stanford University.

[3] A working replica of Dr. Marton's first electron microscope, recently constructed at the National Bureau of Standards for the Smithsonian Institution, will be on exhibit at the Museum of History and Technology in Washington, D.C.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Volume 53, No. 4, April 1969, 30 cents. Annual subscription: Domestic, $3; foreign, $4. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $6; foreign, $7.25. Single copy, $1.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

CURRENT ISSUES OF THE JOURNAL OF RESEARCH

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Robinson, R. A., Paabo, M., and Bates, R. G., Deuterium isotope effect on the dissociation of weak acids in water and deuterium oxide.

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Botter, R., and Rosenstock, H. M., Franck-Condon factors for the ionization of H_2O and D_2O.

Harman, G. G., Topological features of hot carrier induced anisotropic breakdown on silicon diode surfaces.

Sugar, J., The third spectrum of praseodymium (Pr III) in the vacuum ultraviolet.

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